International Journal of Agricultural Science and Research (IJASR)
ISSN(P): 2250-0057; ISSN(E): 2321-0087
Vol. 6, Issue 1, Feb 2016, 147-154

TRANS STELLAR
•Journal Publications •Research Consultancy

COMPARATATIVE PERFORMANCE OF VARIOUS WEEDING EQUIPMENTS

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ABSTRACT

As per the utility of weeding implements a experiment was conducted to evaluate the field performance of various weeding implements to compared at Department of Farm Power and Machinery, Dr. PDKV, Akola. Various parameters such as weeding index, weeding efficiency and field capacity of the weeder were considered during the test. Among hand khurpi, cycle hoe and bullock drawn straight blade hoe, the time required to complete the one hectare field was found minimum in bullock drawn hoe but weeding efficiency was higher in hand Khurpi.

KEYWORDS: Khurpi, Cycle hoe, Weeder, Performance, Trials

Received: Nov 27, 2015**; Accepted:** Jan 13, 2016**; Published**: Jan 21, 2016**; Paper Id.:** IJASRFEB201621

Original Article

INTRODUCTION

Weed growth is a major problem in dry land crops causing a considerable lower yield. The extent of losses depends upon types of weed, their intensity and time of their occurrence and rate of removal. Manual weeding requires huge labour force and accounts for about 25 per cent of the total labour requirement (900-1200 man-hours/hectare) (Nag and Dutt, 1979). In India this operation is mostly performed manually with khurpi or trench hoe that requires higher labour input and also very tedious and time-consuming process. Moreover, the labour requirement for weeding depends on weed flora, weed intensity, time of weeding and soil moisture at the time of weeding and efficiency of worker. Often several weeding are necessary to keep the crop weed free. Reduction in yield due to weed alone is estimated to be 16-42 % depending on crop and location and involves one third of the cost of cultivation (Rangasamy et al, 1993). Weeding and hoeing is generally done 15-20 days after sowing. The weed should be controlled and eliminated at their early stage. Depending upon the weed density, 20-30 per cent loss in grain yield is quite usual which might increase up to 80 per cent if adequate crop management practice is not observed. Mechanical weeding either by hand tools or weeders are most effective (Manjunatha et al., 2014) Kurstzens (2006) found that soil and residue manipulation can assist weed management by killing weeds mechanically, interfering in weed life cycle, facilitating operation and enhancing crop establishment and growth.

Keeping the above facts in view, the experiment was carried out to evaluate the field performance of various weeder for inter-culturing operation.

MATERIAL AND METHODS

The weeding implements were selected on the basis of their field utility. It was thought to evaluate the field performance of mechanical tools for inter-culturing operation. *Khurpi*, wheel hoe and bullock operated straight blade hoe are common tools used by the farmers for intercultural operation in row crops. The details drawings of the weeder are shown following figures 1, 2 and 3.

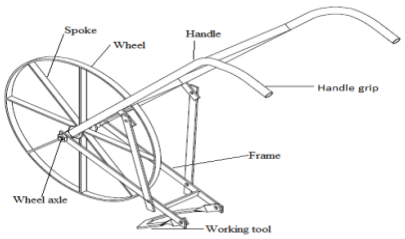

Figure 1: Khurpi

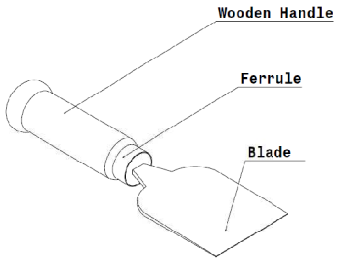

Figure 2: Cycle Hoe

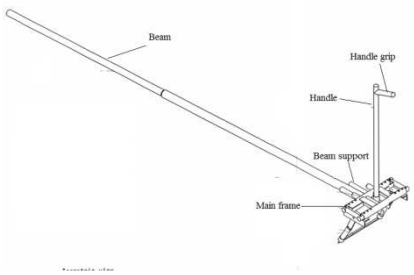

Figure 3: Bullock Drawn Straight Blade Hoe

The field trials were conducted as per RNAM and BIS test codes and procedures. The following treatments were selected for conducting field evaluation trials.

T1 = Weeding operation with hand khurpi

T2 = Weeding operation cycle weeder

T3 = Weeding operation animal drawn blade hoe

Soil moisture Content

Soil moisture content on dry basis was measured by as suggested by Mohsenin (1979) using oven dry method. Five samples of soil were collected randomly from test plots, weight of each samples was taken using an electronic balance. Then these samples were kept in hot air oven maintaining temperature 105 ^{0}C degree for 24 hours. After that, samples were taken out from oven and kept in desiccators. The borne dry weight of sample was recorded by using electronic balance. The moisture content on dry basis was calculated using following formula.

$$\text{Moisture content (\%)} = \frac{w_1 - w_2}{w_2} \text{ x100}$$

Where,

w_1 = initial weight of soil sample, g

w_2 = borne dry weight of soil sample, g

Bulk Density

It is the ratio of mass of soil sample to the volume of core cutter. The bulk density of soil was determined by the

procedure explained by Mohsenin,(1979). Three soil samples were collected at the different locations randomly selected in the test plot using cylindrical core sample. The diameter and length of cylindrical soil sampler were measured. The soil samples were kept in hot air oven maintained at 105 ^{0}C for 24 hour. After that, soil sample were taken out and kept in desiccators. The borne dry weight of soil samples was measured. The bulk density of soil was calculated by following formula.

$$\text{Bulk density}(g/cm^3) = \frac{\text{Mass of soil sample}}{\text{Volume of core cutter}}$$

$$= \frac{M}{\pi D^2 L}$$

Where,

ρ = bulk density, gm/cm^3

M = borne dry weight of soil sample, g

D = diameter of cylindrical core sampler, cm

L = length of cylindrical core sampler, cm

Travelling Speed (km/hr)

For calculating traveling speed two poles 20 m apart was placed approximately in middle of the test run. On the opposite side also two poles were placed in similar position, 20m apart so that four poles forms corners of rectangle, parallel on long side of the plot. The speed was calculated from the time required for machine to travel the distance (20 m) between two poles. Average of such reading was taken to calculate the travelling speed of self propelled weeder. The forward speed of operation was calculated by observing the distance traveled and time taken and calculated by following formula (Mehta *et al.*, 2005).

$$S = \frac{L}{t}$$

Where,

S = forward speed of machine, m/s

L = distance travelled, m

t = time taken, s

Weeding Efficiency

For calculating the weeding efficiency, the weeding efficiency was calculated by using the following formula

$$E_W = \frac{W_1}{W_1 + W_2} \times 100$$

Where,

E_w = Weeding efficiency, %

W_1 = No. of weeds disturbed after weeding in one meter square area

W_2 = No. of weeds undisturbed in one meter square area

Theoretical Field Capacity

For calculating the theoretical filed capacity, working width and travelling speed were taken in to consideration. It is always greater than the actual field capacity. Theoretical field capacity was calculated by using following formula (Mehta *et al.,* 2005).

$$T.F.C. = \frac{S \times W}{10}$$

Where,

T.F.C. = theoretical field capacity (ha/hr)

W = theoretical width of weeder (m)

S = speed of operation (km/h)

Effective Field Capacity

For calculating effective field capacity, the time consumed for actual work and lost for other activities such as turning and cleaning blade when clogged with weeds were taken in to consideration. Effective actual field capacity was calculated by following formula (Mehta *et al.,* 2005).

$$E.F.C. = \frac{A}{T_p + T_1}$$

Where,

E.F.C. = effective field capacity (ha/hr)

A = area (ha)

T_p = productive time (hr)

T_1 = non productive time, hr (Time loss for turning and cleaning blades)

Field Efficiency

Field efficiency was calculated by taking ratio of effective field capacity to theoretical field capacity. It is always expressed in percentage.

It was calculated by following formula (Mehta et *al.,* 2005).

$$\text{Field efficiency (\%)} = \frac{\text{E.F.C.}}{\text{T.F.C.}} \times 100$$

Where,

E.F.C. = effective field capacity

T.F.C. = theoretical field capacity

Plant Damage

Plant damage was calculated by counting the number of plants in 10 rows before weeding and number of the plant damaged in 10 m row length after weeding (Biswas and Yadav, 2004).

$$\text{Plant damage (\%)} = \frac{Q}{P} \times 100$$

Where,

Q = total no.of plant damaged after weeding in 10 m rows

P = total no. of plant before weeding in 10 m rows

Performance of Index

Field performance of tools were assessed through the performance index (P) suggested by Gupta *et al.* (1991). It was calculated by using the following formula.

$$P = \frac{a \times q \times e}{p}$$

Where,

P = performance index

a = output (ha/hr)

q = (100- % plant damaged)

e = weeding index (%)

p = power input

RESULTS AND DISCUSSIONS

The results of field performance evaluation trials of different weeders namely hand khurpi, cycle hoe and animal drawn hoe which were carried out in the farmers field and University field are presented and discussed. Field observations like operational speed, width of operation, number of labourers required for weeding operation soil moisture content, bulk density and cone index were recorded. The data collected during field evaluation trails were analyzed to determine the actual field capacity, field efficiency, weeding index and performance index. Performance result was compared with that of conventional method i.e., weeding operation by hand khurpi. The details performance result in treatment 1 shown in Table 1.

Table 1: Performance result of *khurpi*

Sl. No.	Particulars	Test Trials				
		I	II	III	IV	Avg.
1	Length of furrow, m	70	66.6	55.54	60	63.03
2	Moisture content, %	13.78	14.68	16.45	14.59	14.87
3	Bulk density, g/cc	1.29	1.30	1.31	1.33	1.30
4	Cone Index before operation, kg/cm^2	1.23	1.24	1.25	1.23	1.23
5	Cone Index after operation, kg/cm^2	1.21	1.22	1.21	1.20	1.21
6	Row Spacing, cm	45	45	45	45	45
7	Weeding efficiency, %	92.52	95.69	93.86	97.84	94.97
8	Area covered, ha/h	0.004	0.004	0.005	0.004	0.0042

The average values of soil moisture content, bulk density before and after operation and cone index were found to be 14.87, 1.30 and 1.23 respectively. The average field capacity value of 0.004 ha/h was recorded with hand khurpi.

The data collected during field evaluation trials of cycle hoe were analyzed to determine the field capacity, field efficiency, labour requirement and weeding index and their average values are presented in Table 2.

Table 2: Performance Result of Cycle Hoe

	Parameters	Test Trails				
		I	II	III	IV	Avg.
1	Furrow length(m)	30	41	33	28	33
2	Bulk Density of soil, (g/cc)	1.33	1.30	1.33	1.31	1.31
3	Soil moisture, (%)	13.56	14.03	14.21	13.62	13.85
4	Av. forward speed (kmph)	1.03	1.01	0.91	0.94	0.97
5	Avg. depth of cut, cm	4.15	4.09	4.27	4.33	4.21
6	Avg. Width of cut, (mm)	14.08	15.10	15.00	15.2	14.84
7	Area covered,(ha/h)	0.009	0.010	0.0089	0.009	0.009
8	Time required for one ha, (h)	111.11	100	112.36	111.11	108.64
9	Field efficiency, (%)	62.06	66.00	65.20	63.00	64.06
10	Weeding efficiency, (%)	86.00	85.73	87.34	88.84	86.97
11	Plant damage, %	Nil	1.08	2.32	Nil	0.85
12	Draft, (kg)	9.00	8.5	8.00	8	8.37
13	Power requirement, (kW)	0.026	0.024	0.020	0.021	0.022

On an average, in cycle hoe required 108.64 man-hours to complete weeding operation in one ha area. The results of trials revealed that the average values of soil moisture content and bulk density were found to be 13.85 per cent, 1.30, respectively. It is observed that in cycle hoe had the average field capacity value of 0.009 ha/h and weeding index of 86.97 per cent.

The data collected during field evaluation trials of bullock drawn straight blade hoe were analyzed to determine the field capacity, field efficiency, labour requirement and weeding index and their average values are presented in Table 3.

Table 3: Performance Result of Bullock Drawn Straight Blade Hoe

Sr. No.	Parameters	Test Trails				
		I	II	III	IV	Avg.
1	Furrow length(m)	102	95	110	88	98.75
2	Bulk Density of soil, (g/cc)	1.31	1.35	1.42	1.21	1.32

Table 3: Contd.,						
3	Soil moisture, (%)	13.83	14.61	15.48	14.63	14.63
4	Cone Index, (Kg/cm^2)	4.36	4.43	4.63	5.03	4.61
5	Av. forward speed (kmph)	2.41	2.45	2.33	2.39	2.39
7	Avg. depth of cut, cm	6.61	6.42	6.66	6.70	6.59
6	Avg. Width of cut, (cm)	30.00	29.84	30.22	30.20	30.06
7	Area covered,(ha/h)	0.065	0.067	0.063	0.064	0.064
8	Time required for one ha, (h)	15.38	14.93	15.87	15.63	15.45
9	Field efficiency, (%)	89.90	91.65	89.47	88.67	89.92
10	Weeding efficiency, (%)	81.95	80.02	84.75	82.78	82.37
11	Draft, kg	45.38	46.00	43.00	44.00	44.59
12	Power requirement, (kW)	0.30	0.31	0.27	0.29	0.29

On an average, in bullock drawn straight blade hoe required 15.45 man-hours to complete weeding operation in one ha area. The results of trials revealed that the average values of soil moisture content, bulk density and cone index were found to be 14.63 per cent, 1.32, 1.32 and 4.61, respectively. It is observed that bullock operated straight blade hoe had the average field capacity value of 0.064 ha/h and weeding index of 82.37 per cent.

CONCLUSIONS

From the field trials of various weeder following conclusions could be drawn Among all the weeders, the animal drawn blade hoe recorded maximum values of average actual field capacity and minimum number of man-hrs requirement while the maximum value of weeding index and man-hrs requirement were observed for weeding operation by hand khurpi. As far as concern in cost of operation in terms of Rs/h and Rs/ha, savings in cost and time of weeding operation using the hand khurpi, cycle hoe land animal drawn blade hoe is going to decreased. The animal drawn blade hoe recorded maximum values of average actual field capacity and minimum number of man-hrs requirement while the maximum value of weeding efficiency and man-hrs requirement were observed for weeding operation by hand khurpi.

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